(19) Japan Patent Office (JP)

(12) **Japanese Unexamined Patent Application Publication (A)**

(11) Japanese Unexamined Patent Application Publication Number

H11-66836

(43) Publication date: 09 March 1999

(51) Int. Cl.[6]	Identification codes	FI
G 11 B 33/14	503	G 11 B 33/14 503A

Request for examination: Not yet requested: Number of claims: 5 online (Total of 11 pages)

(21) Application number H9-220407

(22) Date of application 15 August 1997

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(54) [Title of the Invention] Disk Array Device

(57) [Abstract]

[Problem] To create uniform cooling of canisters comprising HDAs and of HDA control circuit boards within a disk array device.

[Means of Resolution] A disk array device comprising an HDD box 8 for supporting and securing a canister 7 that has an HDA 5 and an electronic circuit board 6, an HDD box unit 4 having a plurality of HDD boxes vertically and horizontally, and a plurality of fans 10 for cooling the canisters using cooling air; wherein cooling air is drawn from a lower portion of the disk array device by the plurality of fans and exhausted to the upper portion, so that the flow speed of the cooling air around the respective canisters will be a specific value; and when canisters are not equipped in a portion of the HDD boxes from among all of the HDD boxes, flow rectifying members 12, having essentially the same outer shape as the canisters, are equipped in the HDD boxes wherein canisters are not equipped, to thereby cause the flow speed of the cooling air in the flow rectifying members to be said specific value.

[Fig. 1]
[INSERT FIGURE]
[Counterclockwise from top]
[1] Fan
[2] Separator member
[3] HDD box unit
[4] Column 1
[5] Column 2
[6] Column 3
[7] Column 4
[8] Row 1
[9] Row 2
[10] Row 3
[11] Row 4
[12] Row 5
[13] Row 6
[14] Row 7
[15] Row 8

[Patent Claims]
[Claim 1] A disk array device comprising an HDD (hard disk drive) box for supporting and securing a canister or a plurality of canisters that have an HDA (head disk assembly) and an electronic circuit board for storing and playing back information, an HDD box unit having a plurality of said HDD boxes vertically and horizontally, and a plurality of fans for cooling said canisters using cooling air; wherein

said HDD box units are disposed in plurality in the vertical and horizontal directions;

and cooling air is drawn from a lower portion of the disk array device by the plurality of fans and exhausted to the upper portion, so that the flow speed of the cooling air around the respective canisters will be a specific value;

and when canisters are not equipped in a portion of the HDD boxes from among all of the HDD boxes, flow rectifying members, having approximately the same outer shape as the canisters, are equipped in the HDD boxes wherein canisters are not equipped, to thereby cause the flow speed of the cooling air in the flow rectifying members to be said specific value.

[Claim 2]
A disk array device comprising an HDD box for supporting and securing a canister or a plurality of canisters that have an HDA and an electronic circuit board for storing and playing back information, an HDD box unit having a plurality of HDD boxes vertically and horizontally, and a plurality of fans for cooling the canisters using cooling air; wherein

said HDD box units are disposed in plurality in the vertical and horizontal directions, where a plurality of fans are disposed on a front door and a back door of said disk array device to draw cooling air from the front and back and to exhaust said cooling air from a top cover whereon a fan is disposed, to cause the flow speed of said cooling air in each of the canisters to be a specific value; where

said HDD box units that are disposed in plurality have a gap space formed in approximately the center parts of said front door and said back door, where air is exhausted from the top cover through said gaps; and

a cooling air separator member is equipped for separating the cooling air that has cooled an HDD box unit on the front door side from the cooling air that has cooled an HDD box unit on the back door side in mutually opposite directions.

[Claim 3] A disk array device as set forth in Claim 2, wherein:

said cooling air separator member is either in a flat or curved surface shape.

[Claim 4] A disk array device as set forth in Claim 2 or Claim 3, wherein:

a plurality of fans are provided in said gap space when exhausting said cooling air through said gap space.

[Claim 5] A disk array device as set forth in Claim 1, wherein:

instead of a rectifying member having approximately the same outside shape as said canister, a flat board-shaped rectifying member that extends approximately in the direction of flow of said cooling air is used so as to not change the flow path of said cooling air.

[Detailed Explanation of the Invention]
[0001]
[Field of Technology Containing the Invention] The present invention relates to disk array subsystem, more specifically to structures and layouts of devices for groups of multiple magnetic disk devices, and cooling technologies for devices that are well suited to densification and increased reliability.
[0002]
[Prior Art] Conventional technologies, as disclosed in Japanese Unexamined Patent Application Publication H8-124375, have used symmetry to provide uniform airflow speeds in cooling each of the HDAs (hard disk assemblies) and control circuit boards, to provide uniform cooling effects, when cooling canisters comprising multiple HDAs with m rows (where $m \geq 2$) in series and n columns (where $n \geq 2$) in parallel with a single fan. However, there are the following problems if, for some reason, the canisters for a portion of the HDA and HDA control circuits are missing.
[0003] That is, if, as shown in Fig. 8, the canisters 7, comprising the HDAs 5 and HDA control circuit boards 6 that store and playback information as shown in Fig. 7, at Row 1 Column 4, Row 3 Column 4, Row 5 Column 4, and Row 7 Column 4 are removed from a state wherein the canisters 7 are fully loaded, then "a broader flow with reduced resistance" in the cooling air will occur at the locations from which the canisters were removed, and thus the flow path resistance in the fourth column will be greater than in the first through third columns, and the speed of flow of the cooling air in the fourth column will be less than that in the first through third columns.
[0004] Consequently, the increase in temperature of the HDAs 5 positioned at Row 2 Column 4, Row 4 Column 4, Row 6 Column 4, and Row 8 Column 4 will be greater than the case wherein all of the canisters 7 are loaded.
[0005] The phenomenon described above was measured using the following method. As described in Fig. 9 and Fig. 12, a flowmeter 23 wherein a flow speed sensor is attached to the tip of a long and thin probe was inserted between the canisters 7 and the HDD (hard disk drive) boxes 8 up to a position centered in the depthwise direction in the HDA 5, and the results of measuring the flow speed are shown in Fig. 13. However, because the flow speeds are subequal for the second row and the fourth row, only the results for the second row are shown.
[0006] Moreover, in Fig. 9, Fig. 10, and Fig. 11, airflow speeds were measured at airflow speed measurement point 22a on the left side of the figure for the HDA 5, and the airflow speed measurement point 22b for the right side of the figure for the control circuit board 6 of the HDA., and the airflow speeds were subequal in both positions, so only the results for the measurements of the airflow speed measurement point 22a for the left side of the figure for the HDA 5 are shown.
[0007] In a graph in Fig. 13, the airflow speed is about 2.3 m/sec for the fourth column, when there is an airspeed of 3.6 m/sec for those parts aside from the fourth column, and if it is assumed that the coefficient of thermal diffusion is proportional to the airflow speed, then the increase in temperature in the fourth column will be 1.5 times that of

the other parts, producing the problem of insufficient cooling.

[0008] Moreover, in the conventional device, large disks, with disk diameters in excess of 5 inches, were loaded to load one column of HDAs in the depthwise direction of the device, as disclosed in Japanese Unexamined Patent Application Publication H7-37376, but when a small diameter disk with a diameter of 3.5 inches or less is loaded, it becomes necessary to load HDAs in parallel on the front surface and the back surface of the device rack for high density packaging. While Japanese Unexamined Application Publication H8-124375 is a reference example for the conventional technology, in this Japanese Unexamined Patent Application Publication H8-124375, the airflow that has been heated by a lower rank of HDAs and control circuit boards is used for cooling the higher ranks of HDAs and control circuit boards, and so cannot be used in cooling objects that produce large amounts of heat, such as magnetic disk devices wherein the speed of rotation is in excess of 10,000 rpm.

[0009] That is, the heat generation by the spindle part is the sum of the following, and can be determined experimentally and through calculation:

(1) The disk loss that is consumed through viscous torque of the air when the disk platen is turning.

(2) The arm loss that is consumed through viscous torque of the air generated by inserting the arm, on which the magnetic head is mounted, into the air that is rotating with the disk (where this will vary depending on the position of the magnetic head relative to the disk, and will be maximum when the magnetic head is positioned at the innermost periphery of the disk);

(3) The axle bearing loss that is consumed through friction/viscous torque of the main bearing or fluid bearing that supports the spindle;

(4) The seal loss that is consumed by viscous torque of the magnetic fluid seal that prevents dust from getting into the HDA;

(5) The copper loss that is consumed in Joule heating through electrical resistance of the coil and the electric current that flows through the motor coil; and

(6) The iron loss that is consumed by Joule heating due to the electrical resistance of the eddy current in the iron plate that occurs in the iron plate of the stator when the stator of the motor is excited.

[0010] According to test calculations by the present inventors and others, the maximum amount of heat generation by the spindle part of an HDA wherein 15 3.5-inch disks are mounted will be about 9W at 6,300 rpm, and while it is possible to perform cooling using the method of Japanese Unexamined Patent Application Publication H8-124375, once the speed of rotation reaches 10,000 rpm, the amount of heat produced in the spindle part will be about 27W, so the increase in temperature will be about three times that of 6,300 rpm, and while the flow speed around the HDA to make the increase in temperature be about the same as for 6,300 rpm will have to be about 10 to 12 m/sec, there is a problem in that this is not possible using the method of the aforementioned Japanese Unexamined Patent Application Publication H8-124375.

[0011] When it comes to the "flow rectifying member," described in the claims in the present application, example of flow rectifying members that are conventionally used are disclosed in Japanese Unexamined Patent Application Publication H7-122057, where the first flow rectifying member is proposed to have the cross-sectional shape of the flow rectifying member streamlined in order to eliminate the occurrence of the so-called Karman vortex, and the second flow rectifying member is proposed to have increased the speed of the airflow at a constricted part by constricting the flow.

[0012] On the other hand, the flow rectifying member in the present invention reduces the flow path resistance by expanding and constricting of the flow from the cooling air path, and thus the object, means, operation, and effects are different from those of the method used in the flow rectifying member in said publication.

[0013]

[Problem Solved by the Present Invention] The first problem solved by the present invention is to provide a cooling system for a disk array subsystem wherein the cooling airflow speed around a canister that is downstream from a non-installed canister in the cooling air path is not reduced when a portion of the canisters are missing for some reason in a disk subsystem wherein a single fan cools multiple canisters comprising HDAs in m rows (where $m \geq 2$) in series and n columns (where $n \geq 2$) in parallel, and HDA control circuit boards, as described in Japanese Unexamined Patent Application Publication H8-124375.

[0014] The second problem solved by the present invention is to reduce the increase in temperature of the HDAs and HDA control circuit boards, and the constituent parts thereof, to the same level as at 6,300 rpm even when the spindle speeds of the HDAs are high (at 10,000 rpm) in disk subsystems wherein the canisters comprising HDAs and HDA control circuit boards are disposed in parallel on a front surface and a back surface of a device housing, as described in Japanese Unexamined Patent Application Publication H8-124375, in order to increase the density of packaging HDAs wherein small disks, of 3.5 inches and less, are mounted.

[0015]

[Means for Solving the Problem] The present inventions primarily uses the following structures for solving the aboveproblems:

[0016] A disk array device comprising an HDD box for supporting and securing a canister or a plurality of canisters that have an HDA and an electronic circuit board for recording and playing back information and an HDD box unit having a plurality of HDD boxes vertically and horizontally, and a plurality of fans for cooling the canisters using cooling air; wherein said HDD box unit is disposed in plurality in the vertical and horizontal directions; and cooling air is drawn from a lower portion of the disk array device by the plurality of fans and exhausted to the upper portion, so that the flow speed of the cooling air around the respective canisters will be a specific value; and when canisters are not equipped in a portion of the HDD boxes from among all of the HDD boxes, flow rectifying members, having approximately the same outer shape as the canisters, are equipped in the HDD boxes wherein

canisters are not equipped, to thereby cause the flow speed of the cooling air in the flow rectifying members to be said specific value.

[0017] Additionally, a disk array device comprising an HDD box for supporting and securing a canister or a plurality of canisters that have an HDA and an electronic circuit board for recording and playing back information, an HDD box unit having a plurality of HDD boxes vertically and horizontally, and a plurality of fans for cooling the canisters using cooling air; wherein said HDD box units are disposed in plurality in the vertical and horizontal directions, where a plurality of fans are disposed on a front door and a back door of said disk array device to draw cooling air from the front and back and to exhaust said cooling air from a top cover whereon a fan is disposed, to cause the flow speed of said cooling air in each of the canisters to be a specific value; where said HDD box units that are disposed in plurality have a gap space formed in approximately the center parts of said front door and said back door, where air is exhausted from the top cover through said gaps; and a cooling air separator member is equipped for separating the cooling air that has cooled an HDD box unit on the front door side from the cooling air that has cooled an HDD box unit on the back door side in mutually opposite directions.

[0018]

[Forms of Embodiment of the Present Invention]

Forms of embodiment according to the present invention will be explained in using the diagrams.

[0019] Fig. 1 is a cross-sectional diagram when a disk array subsystem device according to a first form of embodiment according to the present invention is viewed from the front. In the disk array subsystem device of the present invention in this form of embodiment, opening parts are provided in the bottom surface and top surface of an HDD box that contains a canister, where a pair of two identical HDD box units, equipped with fans, are mounted as a vertical pair so that the cooling air will flow upwards, in a structure that prevents an excessive increase in temperature by cooling the constituent parts of both HDD box units by the fan in one HDD box unit if the fan in the other HDD box unit fails.

[0020] Moreover, by having the HDD box unit, which is a vertical pair of two HDD boxes as one set, and by having one set disposed at the front part of the device and another set disposed at the back part of the device, and disposing another two sets of HDD box units on top of the aforementioned two sets of HDD box units, the member that separates the cooling air path system of the lower two-set HDD box unit from that of the upper two-set HDD box unit is secured to the device, where there are a total of eight HDD box units, with two lower sets and two upper sets, which are all identical products.

[0021] The system of the present invention according to Fig. 1 has a front door 1f and a rear door 1r that have air intake openings 1a and 1b in the front and back parts of thedevice, as shown in Fig. 12, where, as shown in Fig. 1, side covers 2a and 2b are attached to the side surfaces, and a top cover 3, having an exhaust hole 3a, is attached to the ceiling thereof.

[0022] The cooling of the constituent parts of this device is performed by air that is drawn in from the outside, as shown in Fig. 12, where air is drawn in through the intake openings 1a and 1b that are provided in the doors 1 (1f and 1r), and after dust has been removed by filters, not shown, equipped on the insides of said intake openings 1a and 1b, the air cools the constituent components within the device, and then is exhausted out of the exhaust hole 3a that is provided in said top cover 3.

[0023] Fig. 1 shows the layout relationships of the HDD box unit 4 that is installed on the inside of the device, the groups of power supplies, the groups of buffer substrates, and the groups of fans for cooling the above. Specifically, this HDD box unit 4 is provided removably on the front surface of an HDD box 8 that is structured of brackets for supporting and securing any number of canisters 7 required, from one to eight, where these canisters 7 comprise the HDAs 5 that performed the recording and playing back of information, and the electronic circuit boards 6 that control said HDAs. Moreover, one or more buffer boards 9 for sending information for the aforementioned canisters 7 and higher devices are also installed. Furthermore, a plurality of power supplies 11, for supplying power to said canisters 7, said buffer boards 9, and fans 10, are also provided. On the back surface of the HDD box 8 is mounted a board (not shown) whereon is disposed connectors for electrically interconnecting the various constituent components such as the canisters 7, the buffer boards 9, the fans 10, and the power supply 11. The bottom surface and the top surface of the HDD box 8 are open, where, in the top part, a fan 10 for generating an upwards flow for cooling the various structural parts of the canisters 7, the buffer board 9, and the power supply 11 is provided on the top part. The bottom surface and the top surface of the HDD box unit 4, as described above, are partially open, with a forced airconfiguration, such as the fan 10 so that the cooling air will flow upwards through these openings in order to increase the cooling efficiency.

[0024] Furthermore, the units of the HDD box units 4, described above, are two pairs above and below (for a total of four HDD boxes), and, for example, HDD box units 4a and 4b are installed. Furthermore, with the aforementioned HDD box unit 4a (for example, Column 1, Rows 1 and 2, and Column 2, Rows 1 and 2 as a single unit) and 4b (for example, Column 3, Rows 3 and [4] and Column 2, Rows 3 and 4 as one unit), as one set, then, in the same way, as shown in Fig. 12, another set of HDD box units 4c and 4d are installed with a gap space 17, as the gap between the back surfaces of the HDD box unit sets 4a and 4b and the other HDD box unit sets 4c and 4d, being between about 50 and 150 mm.

[0025] Similarly, another two sets of HDD box units 4e (such as, for example, Column 1, Rows 5 and 6, and Column 2, Rows 5 and 6 being a single unit) and 4f (with, for example, Column 1 ,Rows 7 and 8, and Column 2, Rows 7 and 8 as one unit) are installed with 4g and 4h on top of the two sets of HDD box units 4a and 4b, and 4c and 4d, already discussed above.

[0026] On the other hand, as shown in Fig. 12, air plates 24a, 24b, 24c, and 24d are attached as device securing members at the bottom of each set of HDD box units 4.

Note that these structural components are shown schematically in the drawing.

[0027] In the cited example that is the conventional example described above, if, for some reason (such as being an optional disk that the customer does not desire), canisters 7 each comprising an HDA 5 and the control circuit board 6 for the HDA 5 are not installed in Column 4 Row 1, Column 4 Row 3, Column 4 Row 5, and Column 4 Row 7 from a fully installed state, or in other words, from the state shown in Fig. 7, then either flow rectifying members 13 made from a box-shaped structural member with the same shape and same dimensions as the outsides of these canisters 7 are provided in the parts wherein the canisters 7 are not installed, or, as shown in Fig. 1, a flat plate-shaped rectifying member 12 is installed approximately along the direction of flow of the cooling air, so that the flow path of the cooling air will be unchanged. The flow speed of the air that cools the canisters 7, which comprise the HDAs 5 and the control circuit boards 6 for the HDAs 5 in the fourth column is thereby caused to be the same as the speed of flow of the air that cools said canisters 7 in the first column through the third column.

[0028] Here Fig. 9 illustrates a partial cross-sectional diagram of the case when a conventional disk array subsystem is viewed from the front. Moreover, Fig. 10 and Fig. 11 illustrate partial cross-sectional diagrams of the disk array system according to the first form of embodiment of the present invention when viewed from the front. Moreover, Fig. 12 illustrates a partial cross-sectional diagram of the disk array subsystem of Fig. 9, Fig. 10, and Fig. 11 when viewed from the side.

[0029] First of all, in order to verify the effects of the present invention, the speeds of the flow of cooling air around the canisters 7 comprising HDAs 5 and electronic circuit boards 6 that control the HDAs 5 were actually measured for the conventional examples such as shown in Fig. 9 and for the cases in Fig. 10 and Fig. 11, which are the present invention. In other words, the speed of flow of the cooling air at the airflow speed measurement point 22 in the vicinity of each of the HDAs 5 and the control circuit boards 6 for the HDAs [5] in the second row and the fourth row were measured as shown in Fig. 9 through Fig. 11.

[0030] As shown in Fig. 12, a flowmeter 23, wherein a flow speed sensor is attached to the tip of a long and narrow rod-shaped probe was inserted to a position in the center, in the depth direction of the HDA 5, in the gap between the canisters 7 and the HDD boxes 8, and the results of the flow speed measurements are shown in Fig. 13. Note that because the flow speeds in the second row are approximately the same as those in the fourth row, only the results for the second row are shown.

[0031] Moreover, in Fig. 9, Fig. 10, and Fig. 11, airflow speeds at the airflow speed measurement points 22a in the gaps between the HDAs 5 on the left side of the figure and the HDD boxes 8 as well as at the airflow speed measurement points 22b in the gaps between the control circuit boards 6 for the HDAs 5 on the right side of the figures and the HDD boxes 8 were measured; however the flow speeds in both positions were subequal, so only the measurements at the airflow speed management points 22a between the HDAs 5 on the left side of the figure and the HDD boxes 8 are shown.

[0032] It can be seen in the graph in Fig. 13 that, for the conventional case shown in Fig. 9, the flow speed in the fourth column was about 2.3 m/sec when the flow speed for other than the fourth column was 3.6 m/sec, so the speed of flow of the cooling air in the fourth column was lower than that in the first through third columns. Moreover, as seen in the conditions of the forms of embodiment of the present invention such as in Fig. 10 and Fig. 11, the flow speeds for all of the first through fourth columns were 3.6 m/sec, so it can be seen that the flow speeds are the same regardless of the column.

[0033] Next a second form of embodiment according to the present invention will be explained using Fig. 2 through Fig. 6. Fig. 2 illustrates a cross-sectional diagram of a disk array subsystem according to a second form of embodiment of the present invention when viewed from the front. In the disk array subsystem device according to the present form of embodiment, openings are provided on the front surface and the back surface of the box unit in a structure wherein fans are provided so that the cooling air flows in parallel in the serial direction. Moreover, one set of box unit groups is disposed in front of the device, and another set of box unit groups is disposed in the back of the devices, and a member comprising a cooling air path system therebetween is securely fastened to the devices.

[0034] In the system according to the present invention as set forth in Fig. 2, a front door 1g and a rear door 1s, having intake openings 1a and 1b at the front and back parts of the devices, are equipped so as to be able to open and close, as shown in Fig. 3, and side covers 2a and 2b are attached on the side surfaces, and a top cover 3 that has an exhaust hole 3a is also attached at the ceiling as shown in Fig. 2,.

[0035] The cooling of the constituent components in this device is performed through air that is taken in from the outside, as shown in Fig. 3, drawn in through the intake openings 1a and 1b in the doors 1 (1g and 1s), and after dust is removed by filters, not shown, provided on the insides of said intake openings 1a and 1b, the constituent components within the devices are cooled and the air is expelled from the exhaust hole 3a provided in the top cover 3. Fig. 2 shows the layout relationships of the group of box units, the group of power supplies, the group of buffer boards, and the group of fans for cooling the above that are installed within the device.

[0036] Specifically, this box unit 14 is structured of brackets for supporting and securing the canisters 7 that comprise the HDAs 5 for storing and playing back information and the electronic circuit boards 6 for controlling the HDAs 5, and are equipped removably on the front surface of the box. Moreover, one or more buffer boards 9 are installed for sending information for the canisters 7 and the higher devices.

[0037] Moreover, several power supplies 11 are provided for providing power to the canisters 7, the buffer boards 9, and the fans 15 and 16. A board (not shown), whereon connectors for electrically interconnecting the various constituent components, including the canisters 7, the buffer boards 9, the fans 15 and 16, and the power supplies

11 are disposed, is equipped on the back surface of said box unit 14.

[0038] The front surface and the back surface of the box unit 14 are open, and fans 15 and 16 are provided on the front door 1g and the rear door 1s for generating a parallel flow for cooling the various constituent components of the canisters 7, the buffer boards 9, and the power supplies 11. As described above, the front surface and the back surface of the box unit 14 are open, and a forced air configuration, such as the fans 15 and 16, is used so as to have a parallel flow of the cooling air through the openings, to achieve improved cooling efficiency. Note that these constituent components are also illustrated schematically.

[0039] Additionally, while in Fig. 2 a single canister 7 is cooled by a single fan 15, multiple canisters 7 (2 or 4 canisters) may be cooled by a single fan 15. Fig. 3 shows a cross-sectional diagram of the disk array subsystem of Fig. 2 when viewed from the side. As discussed above, the structure is such that the fans 15 and 16 for cooling the canisters 7 are attached to the back surfaces of a pair of front and rear doors 1 (1g and 1 s). Moreover, on the back surface of the device (the rear door side), the constituent components of the same structure as on the front side (the front door side) of the device are disposed symmetrically, where there is a gap space 17 between 50 and 200 mm wide between the back surfaces of said front constituent components and said back constituent components.

[0040] The doors 1 (1g and 1s) have air intake openings, not shown, where the air that has cooled the canisters 7, comprising the HDAs 5 and said control circuit boards 6 for the HDAs 5, is expelled by the fans 15 and 16 to the gap space 17. Note that Fig. 3 does not show the control circuit boards 6, but only shows the HDAs 5. In order to expel with efficiency, in the upwards direction, the air that has been expelled into the gap space 17, a fan 18 is equipped in the gap space 17 and also in the top cover 3 above the gap space 17. Because of this, the cooling air flow will be as the cooling air path 19, so as to be able to obtain an efficient airflow speed.

[0041] Fig. 4 illustrates a cross-sectional diagram of the disk array subsystem of Fig. 2 when viewed from the top surface. The exhaust flow 20a that has cooled the canisters 7 on the front of the device, and the exhaust flow 20b that has cooled the canisters 7 on the back of the device, which flow towards said gap space 17, blow in mutually opposite directions, and thus an air separator member 21 that separates the exhaust flows 20a and 20b is provided within the gap space 17 to prevent turbulence of the air due to a collision between said exhaust flow 20a and said exhaust flow 20b, so that said exhaust flow 20a and said exhaust flow 20b will be exhausted efficiently into the gap space 17.

[0042] Moreover, Fig. 5 illustrates a cross-sectional diagram of the disk array subsystem of Fig. 2 when viewed from above. The air separator member 21, explained using Fig. 4, may also be provided as in Fig. 5. The air separator member 21 that is shown here is a flat-shaped air separator member 21a.

[0043] Fig. 6 illustrates a cross-sectional diagram of the disk array subsystem of Fig. 2 when viewed from above. Note that the air separator member 21 explained using Fig. 4 is a flat-shaped air separator member 21a, but the curved-surface air separator member 21b, as in Fig. 6, has even higher air exhaust efficiency.

[0044] Consequently, in disk [array] subsystems wherein canisters, comprising a plurality of HDAs and HDA control circuit boards, are installed in parallel columns on the front and back of a device housing for high density installation of HDAs that are equipped with small-diameter disks of 3.5 inches or less, even if the speed of rotation of the HDA spindles is even greater than the present speeds, a plurality of fans are disposed on the back surfaces of the doors, where a single fan creates a parallel flow in the serial direction to cool a canister comprising a single HDA and HDA control circuit board, where a space having a gap of about 50 to 200 mm is provided between the back surfaces of the canisters on the front and back of the device housing, so that the air that has cooled said canister is expelled into said gap space.

[0045] Moreover, the provision of an air separator member in the gap space prevents the occurrence of turbulence due to the collision of the air flows in mutually opposite directions that have cooled the canisters on the front and back of the device, thereby improving the exhaust efficiency and the cooling efficiency, making it possible to reduce the increase in heat in the HDAs and HDA control circuit boards to a level no more than the current level.

[0046] As explained above, the present invention includes the following examples of configuration:

[0047] In a disk array subsystem wherein a plurality of canisters, comprising m rows (where m ≥ 2) in series and n columns (where n $\geq$ 2) in parallel of HDAs and control circuit boards for the HDAs are cooled by a single fan, means are provided so that the speed of flow of the cooling air around the canisters downstream from a non-installed canister in the cooling air path is not decreased by means of using the flow rectifying member described above, even when there are some canisters that, for some reason, are not installed when there should actually be all of (m x n) canisters installed.

[0048] (1) Means wherein a flat plate-shaped flow rectifying member is used so that the path of the cooling air does not change.

[0049] (2) Means wherein a box-shaped flow rectifying member, made from a structural member with approximately the same shape and same dimensions as the outside shape of said canister, is used instead of a canister comprising an HDA and a control circuit board for an HDA, that is not installed, so that the flow resistance of the cooling air path is not changed.

[0050] Moreover, in disk [array] subsystems wherein canisters comprising a plurality of HDAs and HDA control circuit boards are installed in parallel columns on the front and back of a device housing for high density installation of HDAs that are equipped with small-diameter disks of 3.5 inches or less, the present invention provides means for installing a plurality of fans on the back of the doors wherein a single fan cools each of the canisters that comprise a single HDA and the control circuit board for the single HAD in the serial direction;

for providing a space having a gap of about 50 to 200 mm provided between said canisters on the back and the front; and

for installing an air separator member within a gap space so that the exhaust efficiency and cooling efficiency are not compromised due to the occurrence of turbulence caused by a collision of the air that is blown in mutually opposite directions after cooling the canisters on the front and the back.

[0051] Moreover, even in a disk [array] subsystem wherein said gap space is provided, if there are non-installed canisters, excellent cooling effects can of course be obtained by installing the aforementioned flow rectifying members in those locations.

[0052]

[Effects of the Invention] The present invention makes it possible to provide a disk array system capable of high density packaging, higher than conventional, along with performing the high efficiency cooling without a drop in the cooling performance in any constituent component by means of newly providing a flow rectifying member, even when there is a layout structure wherein some constituent members are not installed, in a disk array subsystem that is structured of groups of canisters, comprising a plurality of HDAs and control circuit boards for HDAs, and constituent components related thereto.

[0053] Moreover, the present invention makes it possible to provide a disk array system that allows high-density mounting of a plurality of magnetic disk devices, with small-diameter disks that are 3.5 inches or less, becauseeven when the amount of heat generated is greater than in conventional devices and the speed of rotation of the HDA spindles is greater than it has been conventionally, the increase in temperature of the HDAs and the HDA control circuit boards was made no higher than at present by improving the exhaust efficiency and cooling efficiency in a disk array subsystem comprising a group of canisters that comprise a large number of HDAs to be loaded with small-diameter disks, no more than 3.5 inches, and HDA control circuit boards, along with associated constituent components, by providing means whereby multiple fans are disposed on the back surfaces of doors, means whereby a single fan cools constituent components such as canisters in the serial direction, means whereby a gap space and a fan for exhausting the air are provided, and means whereby an air separator member is provided in said gap space.

[Simple Description of Drawings]

[Fig. 1] A cross-sectional diagram of a disk array subsystem according to a first example of embodiment of the present invention, viewed from the front.

[Fig. 2] A cross-sectional diagram of a disk array subsystem according to a second form of embodiment of the present invention, viewed from the front.

[Fig. 3] A cross-sectional diagram of the disk array subsystem of Fig. 2, viewed from the side.

[Fig. 4] A cross-sectional diagram of the disk array subsystem of Fig. 2, viewed from the top.

[Fig. 5] A cross-sectional diagram of the disk array subsystem of Fig. 2, viewed from the top, which is a diagram for explaining the application of a flat-shaped air separator member as the air separator member.

[Fig. 6] A cross-sectional diagram of the disk array subsystem of Fig. 2, viewed from the top, which is a diagram for explaining the application of a curved-surface air separator member as the air separator member.

[Fig. 7] A cross-sectional diagram of a conventional disk array subsystem, viewed from the front, which is a diagram for explaining the flow of the airflow speed when all of the canisters are installed.

[Fig. 8] A cross-sectional diagram of a conventional disk array subsystem, when viewed from the front, which is a diagram for explaining the flow of the airflow speed when a portion of the canisters are not installed.

[Fig. 9] A partial cross-sectional diagram of a conventional disk array subsystem, when viewed from the front, which is a diagram for explaining the airflow speed measurement points, etc.

[Fig. 10] A partial cross-sectional diagram of a disk array subsystem according to the first form of embodiment of the present invention, when viewed from the front.

[Fig. 11] A partial cross-sectional diagram of a disk array subsystem according to a first form of embodiment of the present invention, when viewed from the front.

[Fig. 12] A partial cross-sectional diagram of the disk array subsystem of Fig. 9, Fig. 10, and Fig. 11, when viewed from the side.

[Fig. 13] A graph of the cooling airflow speeds for the canisters in the fourth column in the disk array subsystems of Fig. 9, Fig. 10, and Fig. 11.

[Explanation of Codes]

1: Door
1f: Front door in the first form of embodiment
1r: Rear door in the first form of embodiment
1a: Intake opening in the front part of the device in the first form of embodiment
1b: Intake opening in the back part of the device in the first form of embodiment
1g: Front door in the second form of embodiment
1s: Rear door in the second form of embodiment
2: Side cover
2a: Side cover on the left side of the device
2b: Side cover on the right side of the device
3: Top cover
3a: Top cover exhaust opening
4: HDD box unit
4a: Bottom side HDD box unit of the set at the bottom part of the front of the device
4b: Top side HDD box unit of the set at the bottom part of the front of the device
4e: Bottom side HDD box unit of the set at the top part of the front of the device
4f: Top side HDD box unit of the set at the top part of the front of the device
4c: Bottom side HDD box unit of the set at the bottom part of the rear of the device
4d: Top side HDD box unit of the set at the bottom part of the rear of the device
4g: Bottom side HDD box unit of the set at the top part of the rear of the device

4fh Top side HDD box unit of the set at the top part of the rear of the device
5: HDA
6: Electronic circuit board for controlling an HDA
7: Canister
8: HDD box
9: Buffer board
10: Fan
10a: Fan for cooling a canister
10b: Fan for cooling a power supply
11: Power supply
12: Flat-shaped rectifying member
13: Box-shaped rectifying member comprising a structural element with the same shape and same dimensions as the outer shape of a canister
14: Box unit
15, 16: Fans corresponding to canisters
17: Gap space
18: Fan corresponding to the gap space
19: Cooling air path
20: Exhaust airflow
20a: Airflow for exhausting the air that has cooled the device on the front side
20b: Airflow for exhausting air that has cooled the device on the back side
21: Air separator member
21a: Flat-shaped air separator member
21b: Curved surface air-separator member
22: Airflow speed measurement point
22a: Airflow speed measurement point in the gap between the box and the left side of the HDA
22b: Airflow speed measurement point in the gap between the box and the right side of the control circuit board
23: Flowmeter
24 a, 24b, 24c, 24d: Air plates

[Fig. 1]
[Fig. 1]
[INSERT FIGURE]
[Counterclockwise from top]
[1] Fan
[2] Separator member
[3] HDD box unit
[4] Column 1
[5] Column 2
[6] Column 3
[7] Column 4
[8] Row 1
[9] Row 2
[10] Row 3
[11] Row 4
[12] Row 5
[13] Row 6
[14] Row 7
[15] Row 8

[FIG. 2]
[FIG. 2]
[INSERT FIGURE]

[FIG. 4]
[FIG. 4]
[INSERT FIGURE]
[TOP] Back side of the device
[BOTTOM] Front side of the device

[FIG. 5]
[FIG. 5]
[INSERT FIGURE]

[FIG. 3]
[FIG. 3]
[INSERT FIGURE]
[LEFT] Front side of the device
[RIGHT] Back side of the device

[FIG. 6]
[FIG. 6]
[INSERT FIGURE]

[FIG. 7]
[FIG. 7]
[INSERT FIGURE]
[Counterclockwise from bottom]
[1] Column 1
[2] Column 2
[3] Column 3
[4] Column 4
[5] Row 1
[6] Row 2
[7] Row 3
[8] Row 4
[9] Fan
[10] Row 5
[11] Row 6
[12] Row 7
[13] Row 8

[FIG. 8]
[FIG. 8]
[INSERT FIGURE]
[Counterclockwise from top]
[1] Fan
[2] Column 1
[3] Column 2
[4] Column 3
[5] Column 4
[6] Row 1
[7] Row 2
[8] Row 3
[9] Row 4
[10] Row 5
[11] Row 6
[12] Row 7
[13] Row 8

[FIG. 9]
[FIG. 9]
[INSERT FIGURE]
[Counterclockwise from bottom]
[1] Column 1

[2] Column 2
[3] Column 3
[4] Column 4
[5] Row 1
[6] Row 2
[7] Row 3
[8] Row 4

[FIG. 10]
[FIG. 10]
[INSERT FIGURE]
[Counterclockwise from bottom]
[1] Column 1
[2] Column 2
[3] Column 3
[4] Column 4
[5] Row 1
[6] Row 2
[7] Row 3
[8] Row 4

[FIG. 11]
[FIG. 11]
[INSERT FIGURE]
[Counterclockwise from bottom]
[1] Column 1
[2] Column 2
[3] Column 3
[4] Column 4
[5] Row 1
[6] Row 2
[7] Row 3
[8] Row 4

[FIG. 12]
[FIG. 12]
[INSERT FIGURE]
[LEFT] 1f: Front door[RIGHT] 1r: Rear door

[FIG. 13]
[FIG. 13]
[INSERT FIGURE]
[Vertical axis]
[1] Cooling airflow (m/sec)

[Legend in the graph]
[2] For the case in Fig. 9 (conventional example)
[3] For the case in Fig. 10 and Fig. 11 (present invention)

[Horizontal axis]
[4] Position of flow speed measurement
[5] Row 2, Column 1
[6] Row 2, Column 2
[7] Row 2, Column 3
[8] Row 2, Column 4

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